THE MODEL ENGINEER

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In this issue

Mr. H. G. Greg, of Styal, Cheshire, has solved the transport problem by means of a miniature traction engine, which with a couple of bottles of water carried on a trailer and a bucket of coal, will run for many miles. It can haul half a ton and climb steep hills, and a year's tax costs only 5/-.

THE MODEL ENGINEER

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Smoke Rings

Last Week's Cover Picture

THE very attractive motor cabin cruiser depicted in last week's cover picture is the *Slickery,* owned by Mr. R. O. Porter, of Virginia Water. She was illustrated, with her owner, on page 300 of our 2,000th issue, on September 7th last. The *Slickery* was built many years ago, but has lately been thoroughly overhauled and modernised; she is about 5′ 6″ long, and is powered by a Stuart Turner 30 c.c. two-stroke engine. Her graceful lines and the excellent proportions of her upper works combine to make her one of the most handsome models of her type. She is well known to devotees of the Farnborough Regatta.

* * *

The "Ark Royal"

ANY readers who may, even yet, harbour doubts as to the fate of H.M.S. *Ark Royal,* may be interested to know that we have just received an order from one of the officers of that ship for certain back numbers of the "M.E."

* * *

In Our Shop Window

MR. A. J. MAXWELL'S 5″ gauge replica of an old-time G.W.R. goods locomotive, recently finished by Mr. F. H. Baldwin, and to which reference was made in our "Editorial Comments" on November 2nd last, is now on view in our shop-window. It has passed its steam trials, and will remain in our care for a short while, and will then be returned to Mr. Baldwin for painting. An account of the trials will appear in our pages very shortly; but the engine's general behaviour was such that she should prove a useful and popular addition to the stalwart stud that does such yeoman service at exhibitions and other peace-time functions.

The Late Captain R. S. Alston

I RECORD with very great regret the death of Captain R. S. Alston, of Hambrook, Bristol. who passed away on November 11th, through an illness following an operation which took place earlier in the year. Captain Alston was a devoted reader of THE MODEL ENGINEER, and almost knew the contents of our many volumes by heart. On several occasions when an early article has been referred to in conversation, he has been able immediately to quote the date of the issue in which it appeared. He was well known as a collector and restorer of models of old-time engines, and of books and data relating to early engineering practice. An authority on Cornish pumping engines, he had often explored the country in search of photographs and data on mine pumping equipment. He was a regular and welcome visitor to our annual "M.E." Exhibitions, and at the Norwich and Nottingham shows he was an equally popular figure. At Nottingham he acted as a Competition Judge, in conjunction with Mr. A. J. R. Lamb. His profound knowledge of engineering history and details of practice made him a most helpful and stimulating critic. Always ready to recognise and praise accurate modelling, he could be equally forceful in his criticism of faulty work, but his critical comments were never offered in any but a most helpful and friendly spirit. His many friends in the model engineering world and in the Newcomen Society, of which he was a member, will feel that his passing leaves a real gap in the ranks of those who count, and his kindly and cheerful personality will cause him long to be remembered with affection.

Percival Marshall

Removing Pulleys from Shafts

By W. M. Halliday

AN extremely useful and effective extraction device for removing pulleys, sprockets and gears from shafts is illustrated. The advantages of this type of tool are (a) that it can be utilised for extracting wheels in very restricted places, such as on motor shafts, where the pulley is located close to the casing; (b) no damage is caused to pulley or shaft; and (c) a very powerful force can be exerted on the part to be withdrawn, which has proved amply sufficient even in cases where such parts are fitted on taper-ended shafts that have become badly rusted after a long period of use; conditions which defied removal of the part by ordinary tools.

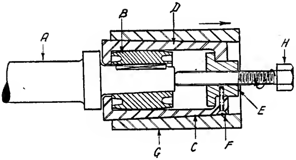


Fig. 1.

Referring to the illustration (Fig. 1), this shows a sectional view of the extractor in position for withdrawing a belt pulley from the tapered end of a shaft, *A*, to which it is keyed. The belt pulley, *B*, is of ordinary shape and pattern.

C and *D* are two halves of a split sleeve, which is bored out before splitting, to be a clearance fit over the outside diameter of the wheel or pulley to be removed. This inner bore is in the form of a chamber, a hole being bored clean through, slightly larger in diameter than that of shaft *A* at one end, and at the other end large enough to take the shouldered bush, *E*, as shown. This sleeve is also turned up on outside to a slight taper, this being approximately 10° inclusive. The sleeve is then split to form the two parts *C* and *D*.

The shouldered bush, *E*, is provided with a threaded hole centrally located to take the adjustable screw, *H*. *E* is also secured permanently to part *C*, as shown in right-hand view in Fig. 2, vee-head screw *F* being employed for this purpose. One screw will be found sufficient, as its function is only to secure both pieces together to facilitate handling and storage, etc., no weight or pressure being subjected to this screw fastening, such pressure as arises from extraction being taken up by the inner shoulder of bush, *E*, bearing against right-hand end wall of parts *C* and *D*.

Heavy broken line in Fig. 2 shows part *D* in partial position in relation to members *C* and *E*.

G is an outer mild steel casing, being bored out the same taper as that outside of *C* and *D*, but slightly smaller in size, so that *G* is caused to overhang a short distance at right-hand end. The outside of *G* is hexagon to enable a standard key being used to hold the device whilst locking or releasing the extracting screw, *H*.

The method of using this extractor will be apparent from reference to the view in Fig. 1. Part *C*, together with affixed bush, *E*, is first passed over pulley to be withdrawn, then other half sleeve, *D*, is placed in position over pulley. The casing, *G*, is then passed over these parts, and given a smart blow with lead or brass hammer, so driving it tightly home, and thereby securing half sleeves together. Screw, *H*, is then inserted and screwed down until contacting with the shaft end, further screwing causing the pulley to be forced off its shaft.

When pulley, etc., has been removed from shaft, a smart tap with a hammer on the end of outer casing, *G*, in opposite direction to that given at beginning, will enable parts to be removed readily from the pulley.

Where it is necessary to safeguard the shaft end against burring over as a result of action of the end of screw, *H*, a small cap of brass may be made up so as to fit over the end of the screw, so preventing marring of the end of the shaft.

Screw, *H*, should, of course, be made of a tough steel, preferably case-hardened at ends, and the outer casing, *G*, similarly case-hardened, especially at ends, to prevent undue bruising as a result of hammer action required.

An extracting tool of this design will be found extremely useful, and with very small adaptations will be able to cope with differing sizes of pulleys or gears quite easily, and it will be found to afford removal when other more orthodox types of tools fail.

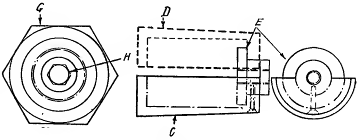


Fig. 2.

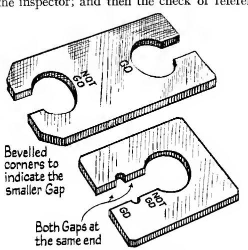
* Gauges and Gauging

A series of great value to engineers of all classes, particularly those who are engaged upon National service

By R. Barnard Way

IN continuation of our study of the different types of gauges that may be met with in the fully-equipped workshop, there are a few considerations that must be gone into first. There are a good many distinct varieties when the product is an intricate one, and, short of taking one particular product and seeing its various parts right through from start to finish, we cannot hope to do more than set down general principles.

Classified broadly, we have three main types. There is the working gauge, held by the mechanic to gauge his work; the inspecting gauge, carried by the inspector; and then the check or reference gauge kept in the tool-room for checking the second type. Figures quoted from a well-known rifle factory show that their particular manufacture consists of 125 separate parts, involving about 700 different processes or operations in the making. To check these operations, 1,750 working gauges are needed; but as there are many machines wholly engaged in the same operation, and each machine has a gauge, this number must be multiplied several times. The inspecting gauges number at least 1,750, and the same applies to the check gauges.

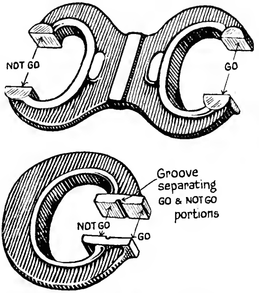


Two types of snap gauges.

Not all the three types of gauges will be made to the same limits, however, for reasons that will soon be plain. Let us go back to that simple spindle in its hole. If the tolerance for the spindle diameter is 0.005″, and the minimum diameter is to be 1.000″, then its maximum is to be 1.005″. The inspecting gauge will be made to these figures precisely, but the working gauges will be made with dimensions 10 per cent. inside those of the inspecting gauge. In this way, the dimensions will be 1.0005″ for the low limit and 1.0045″ for the upper. If a nominal dimension is added, it must, of course, be halfway between these, namely at 1.0025″.

The idea in this is to make sure that every piece that passes the workman's gauge will pass the inspector's gauge, and, consequently, much argument will be avoided. If the inspector rejects a piece, then the indications are clear; either the workman has been hasty and careless in gauging, or if that was not the case then his gauge is worn and needs immediate replacement. Disputes are frequent when both work and inspecting gauges are made to the same size. Working gauges wear much quicker than inspecting gauges, owing to the rougher handling they usually receive.

There are four ways in which limit gauges are marked. A plug or ring gauge may be "max." (for maximum), "high," +, or "not go," for the larger size. Alternatively, we find "min." (for minimum), "low," −, or "go," for the smaller size. We prefer the most usual forms of "not go" and "go," these giving quite clear instructions to their users.



Two types of horseshoe external gauges.

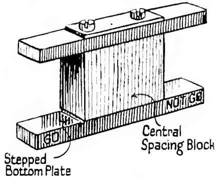
The "go" end is always longer than the "not go," and in the case of a plug gauge will be $1\frac{1}{2}$ times the diameter it is to gauge. When

* *Continued from page 576, "M.E.," November 23, 1939.*

the dimension is marked in figures, as it always should be, these should be carried to three places of decimals, regardless of whether the third figure is a 0, thus 1.000″, 1.050″ or 1.500″.

The simplest form of gauge we have already seen, the plug and ring, and also the snap gauge. Other types that we must include are profile or contour gauges, taper gauges, flush pin gauges and indicating gauges. Amongst this latter class are several most interesting types, with which we shall deal in due course. Then there are some extremely interesting new methods employed, in the form of optical magnification of manufactured pieces compared with the ideal profile. These also will come in for attention in their turn.

The gauges we show are of simple type, from the products of the tool-room to those of the factory with special facilities for such work. There are three general varieties of gap gauge, solid, built-up, and adjustable; the first two are easily produced in any tool-room, the last is more usually a special affair. The solid type may be in the



A built-up external gauge.

form of a simple plate, made from a piece of the steel usually known as ground flat stock. This useful material is tool-steel, and is to be had in a good selection of sizes and thicknesses, its faces are guaranteed to be parallel. You will see from our sketch that there are two usual arrangements of the testing gaps. The one with the two gaps at the same end is quicker in use, as there is no need to reverse the gauge to make the two tests.

The horseshoe type can, in the same way, be made single- or double-ended. Needless to say, perhaps, the maximum size is the outer end of the jaws always. The material from which this type of gauge is made would be either a drop stamping or malleable casting, with the finished surfaces case-hardened.

Built-up gauges are usually of the form here shown, from which it can be seen to be simple enough, though it demands great care in its making. The central block must be ground very finely to the " not go " size, the final finish being put on by lapping. The top and bottom plates must also be ground and lapped, so that they will wring on to the block, staying in position when held up without any apparent support. A step must be formed on one of the plates, to the depth of the amount of tolerance, it is usual to cut a groove across at the division line, as shown. Long screws and nuts secure the three pieces together.

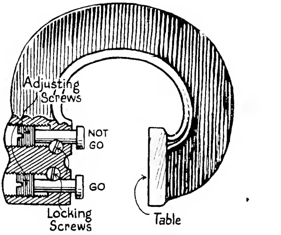
The wringing together of finely finished flat surfaces is familiar enough to the man who has had anything to do with the usual types of reference gauges in the tool-room. It is not easy to emulate, demanding the most patiently accurate work, especially in the final lapping, but it is a great satisfaction to be able to produce two surfaces in steel that, when pressed together with a sliding motion, will stick so that no ordinary force can pull them apart. You will pass as a gauge-maker when you can do that. The trick, by the way, for getting the blocks apart is to twist them just in the same way as you put them together. It is believed that the attraction of the molecules of the steel for each other in the two plates is enhanced by the absence of any air between them, this being squeezed out. Of course, we have also the atmospheric pressure squeezing the two into contact, without any intervening layer to assist separation.

It is frequently found in practice that the central spacing block is built up in layers of $\frac{1}{8}$″ thick plate, accurately lapped so that they will wring together. A large stock of such plates makes the quick assembly of a number of built-up gauges an easy matter.

We illustrate in part section a horseshoe gauge with adjustable anvils. In this connection, we ought to explain that the gauging pads or points are usually referred to as " anvils," and the opposite pad may be the " table." The arrangement is simple enough, as can be seen, consisting of plungers with fine threaded screw ends that run in screwed holes. Nicks for a screwdriver make adjustment easy, and locking screws fix the position of the plungers. Setting the plungers is done by reference to fixed gauges of the block type. The adjusting screws may, perhaps, not be in one piece with the plungers, these having flats on their sides for locking purposes.

Yet another adjustable type of gauge, this one for internal testing, is shown. We have selected this from several available, space does not permit more than one. Here there are two plungers, sliding in sockets, locked by set-screws. A conical plug can be drawn in by means of a fine-threaded screw, and the movement forces out the plungers, these being re-locked by the set-screws. This gauge, made by the celebrated Swedish firm, Johansson, can be an extremely useful tool, permitting as it does quite a considerable range of adjustment. Wearing of the gauging pads is unimportant, as readjustment is an easy matter, not that much wear is likely to occur with ordinary handling. Re-setting is done with reference to fixed gauges, which are available in an enormous range of sizes, both internal and external, their truth being guaranteed to the ten-thousandth part of an inch. These are the products of firms whose business it is to make them and nothing else.

Incidentally, during the course of this series, we have had much occasion—and shall have further occasion—to refer to thousandths of an inch, either in words or figures. It has come to be the fashion in recent years, especially in advertising, to make much play about precision in



An adjustable external gauge.

manufacture, claiming exactness to " the one-thousandth part of an inch." Most of this is just nonsense, for there are very few mechanical devices in domestic or similar everyday use that demand such degree of precision in manufacture. There are some that can be thought of, steel ball-bearings, perhaps, certain motor-car parts, notably fuel pumps for compression-ignition engines. No doubt the reader can think of others, but they are not so common.

The fact is that there are not many machine tools that can finish a job to closer limits than one five-hundredth, and it needs a highly skilled tool-room lathe hand to do that on a lathe. Only the grinding machine can improve upon this, finishing down to one two-thousandth, or even better.

To guarantee accuracy to 0.001″ even needs first rate equipment. Beyond this, in regular working, is the job for the specially equipped shops where gauges are made, and there they do know how to reckon in ten-thousandths, and perhaps beyond. If you buy a set of Johansson or Pitter gauge blocks, or a good set of plug and ring gauges, or some similar outfit, you have something that is true to size, certainly exact to one ten-thousandth of an inch. But they are not easy to make.

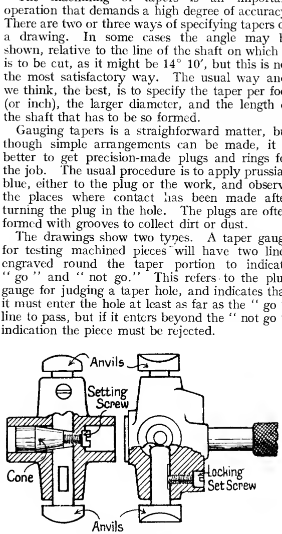
There are measuring machines—we shall see some presently—that can record less than the hundred-thousandth part of an inch, but what shall we say of number 37 in the United States standard sheet iron and steel gauge? Solemnly set out in the Act of Congress in 1893, the thickness of No. 37 is given as 0.006640625″! No other standard in any country in the world is based on the ten-thousand-millionth part of an inch, but this one is, and three others in the same set-out are gauged to the thousand-millionth part. No doubt all are familiar with the handy circular sheet metal gauges with the slits by which you can discover what number any given sheet is gauged at. Well, next time you see the U.S. sheet iron gauge, look for No. 37, regard it with awe and think of what it records. Think also of the gauge maker who cut that slit, and the responsibility that rests upon his shoulders if he really takes his job as seriously as he should.

By the way, the same Act of Congress says that a margin of error of $2\frac{1}{2}$ per cent. either way will not matter! We only set this down to show that a great deal of talk about " thou's " is just what we said before, nonsense. It is time now to return to the stricter subject of gauges.

The machining of tapers is an important operation that demands a high degree of accuracy. There are two or three ways of specifying tapers on a drawing. In some cases the angle may be shown, relative to the line of the shaft on which it is to be cut, as it might be 14° 10′, but this is not the most satisfactory way. The usual way and, we think, the best, is to specify the taper per foot (or inch), the larger diameter, and the length of the shaft that has to be so formed.

Gauging tapers is a straighforward matter, but though simple arrangements can be made, it is better to get precision-made plugs and rings for the job. The usual procedure is to apply prussian blue, either to the plug or the work, and observe the places where contact has been made after turning the plug in the hole. The plugs are often formed with grooves to collect dirt or dust.

The drawings show two types. A taper gauge for testing machined pieces will have two lines engraved round the taper portion to indicate " go " and " not go." This refers to the plug gauge for judging a taper hole, and indicates that it must enter the hole at least as far as the " go " line to pass, but if it enters beyond the " not go " indication the piece must be rejected.

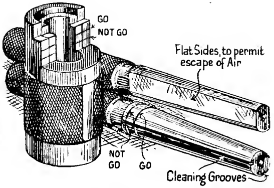


The Johansson adjustable internal gauge.

The ring gauge for judging the tapered shaft has part of its top cut away as shown in the sketch. The " go " and " not go " lines are engraved clearly on the vertical side of the stepped portion.

For judging tapered holes that do not run right through the piece, a cut-away type of plug must be used to permit the escape of air, which would otherwise be compressed into the bottom of the hole and would certainly interfere with the proper entrance.

The " go " position on the plug gauge should correspond precisely with the " not go " line on the ring gauge, when inserted into it. When this is no longer the case, both are overdue for checking.



Taper gauges—plug and ring.

Taper gauges for testing long taper pins, or similar work, can be made on the bench by screwing down two flat plates with precisely finished edges. With a little attention to the setting of the second plate, an excellent gauge is thus available. Another type of gauge for taper work consists of a central rod upon which two short taper blocks are fixed. The upper one has a maximum diameter and the lower one a minimum diameter, corresponding to those indicated in the specification. A gauge of this sort can be used to test the hole for truth by trying to shake it when properly inserted.

Gauge makers offer a useful outfit of taper blocks, rounded on one edge and lightly squared off on the other, so that two of them can be wrung together. In this way a large variety of very exact tapers can be formed for testing tapered holes.

Though we have said that we prefer the method of describing tapers in terms of so much per foot, it must be admitted that the corresponding angle has to be known, in order that the man in the workshop can set over his lathe loose headstock or top slide-rest. To convert inches per foot into an included angle, or angle with the centre-line, is no great matter to the man knowledgeable in trigonometry; that science is not expected of the average mechanic, and so an included angle is usually mentioned on the drawing. The angle with the centre-line is, of course, half the included angle.

Every workshop handbook provides a set of tables giving these angles, so that the lathe hand can see at a glance what the angle is corresponding to a given taper in inches per foot, or, alternatively, a cone angle.

(To be continued)

Hints and Gadgets

Improvising a Blower

To make blowing apparatus for a gas blowpipe, I always use the blowing end of the domestic vacuum cleaner; it is easily adapted and gives a constant supply of air. There is, however, one precaution to take, viz., to switch on the cleaner before the gas. I found this out accidentally; there was a loud explosion which blew out the end of the cleaner, also dust. Evidently, turning on the gas first caused a little to enter the cleaner, via air line, and was touched off by a spark from the brushes.—S.C.T.

A Home-Made Tool-Holder for Light Work

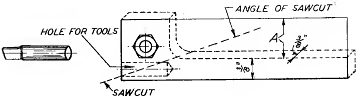
This little tool-holder was made up both cheaply and easily, and the tools to fit it cost next to nothing.

A piece of flat mild steel, say, $\frac{3}{8}'' \times 1'' \times 4''$, is drilled with a $\frac{1}{4}''$ hole, and the piece marked *A* is cut out with a hacksaw and cleaned up to a neat square shank. Next, drill another hole into the end where shown, and make a saw-cut down from the top of the holder to meet the lower drilled hole, which latter, incidentally, should be carefully drilled, as it will hold the tool later on.

Another hole is drilled across the holder of a size that will tap out $\frac{1}{4}''$ Whitworth. After this has been done, the hole is opened out through one of the wings to clear the thread of the $\frac{1}{4}''$ hexagon-head screw which is inserted.

Tools for this holder can be made up from $\frac{1}{4}''$ round stock, which can be purchased everywhere.

The sizes suggested are for a 2″ centre lathe, but they may be increased as desired.—F.C.



*Simple Photographic Enlargers

How to construct inexpensive apparatus, conforming to modern requirements, for making real pictures out of amateur snapshots

By " Kinemette "

IF the light is closer than infinity, the image will be formed *farther away* from the lens than the stated focal distance, in accordance with the rules of conjugate focus. Taking this to its ultimate conclusion, if the light is brought to a distance equal to the stated focal length from the lens, the image will be formed at infinity—which means, in a practical sense, that it will not converge or " condense " the light rays at all, but will form a parallel beam, like that of a searchlight. At a shorter distance still, the beam becomes divergent.

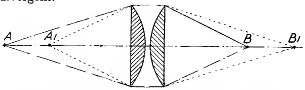


Fig. 6. Diagram illustrating the meaning of the term " conjugate focus." If the condenser is of suitable focal length to focus the rays of the lamp at A to a point at B, then shortening the " back focus " to A1 will lengthen the " front focus " to B1, and *vice versa*.

It follows, therefore, that if a condenser of, say, 4" focal length is employed, the light must, in any circumstances, be situated *more* than 4" from its centre, and the objective must also be more than 4" away—in practice, considerably more. The relative positions, outside these limits, are capable of some adjustment, remembering always that lengthening the back focus will shorten the front focus, and vice versa, as shown in Fig. 6.

This somewhat involved explanation is given, not as an excuse to ventilate an academical curiosity of theoretical optics, but to demonstrate the absurdity of trying to use a 5" focus objective lens in conjunction with a 6" focus condenser, or of trying to get results with the light too close to the latter. A certain amount of juggling with the position of the lamp is almost certain to be necessary with a new enlarger. Theoretically, the lamp position should be varied to suit every alteration in the extension of the objective lens, as required by varying degrees of magnification; but, in practice, using " pearl " or opal lamps, it is possible to find a position which gives quite good results over a substantial range. The lamp must also be centred so that the most effective part of the illuminated area of the bulb coincides with the optical centre, and it may then be fixed in position as shown in the example illustrated in Fig. 1.

*(*Continued from page* 613 "*M.E.*" *November* **30, 1939.**)

It may be mentioned that the objective of an enlarger is usually extended to almost twice its infinity focus when working at moderate magnification, say two or three diameters, and thus the focal length of the condenser does not need to be quite so short as might at first appear necessary.

The problem of making very short-focus condensers of large covering power is a very difficult one from the optician's point of view, as there are limits to the curvative practicable, and the use of more than two lenses is liable to result in considerable loss of light by internal reflection and dispersion. Another incidental trouble is the spectrum effect at the margins of the lenses, which cause troublesome colour fringes on the projected image. For these reasons, comparatively long-focus objectives, which allow also of the use of longer-focus condensers, help to simplify matters, although they require a greater working distance of the enlarger for a given magnification. This may be a serious objection in miniature enlargers which work in a confined space.

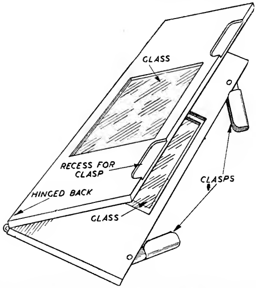


Fig. 7. A hinged " sandwich " type of negative carrier for dealing with flat or roll films ; the design allows of dealing with the latter in a length, if desired.

Negative Carrier

This occupies the same position as the slide holder of an ordinary projection lantern, and must be located perfectly square both ways with the horizontal axis, at a position as close as possible to the front of the condenser, if such is fitted; but, in any case, its location must be

definite and not subject to any variation relative to that of the lens, once the latter is focussed. It is usual to provide a slot in the enlarger body, into which the carrier slides, fitting sufficiently closely to avoid leakage of light when in place.

In order to allow of close fitting, the actual frame of the carrier which takes the negative must be sunk or rebated back, so that the latter, and the clips, or other means of securing it in place, are clear of the surface. Plate negatives require only very elementary provision in this respect, but films must be clamped between two sheets of glass to keep them flat, and thus take up more depth in the carrier, to say nothing of the room occupied by the springs or other means of applying the necessary clamping pressure. In commercial enlargers, the film carrier is often made in the form of a "sandwich," consisting of two metal plates with glass-panelled masking apertures, hinged together and provided with spring clasps, so as to exert pressure on the film inserted between them (Fig. 7).

A very common dodge in amateur-constructed enlargers is to fit the negative in a double dark slide, the shutters of which are withdrawn to their full extent when it is inserted in the enlarger.

Carriers are sometimes made with mechanical movements to rise, traverse and partially rotate, also with adjustable masks. These provisions are useful in composing the picture or utilising a portion of the negative, but can hardly be regarded as necessary in ordinary circumstances. If special masking is desirable, a paper mask inside the carrier, and in contact with the film, can be used; and in vertical enlargers it is possible to obtain all required movements without mechanical means, simply by allowing some latitude in the sideways fit of the carrier in its slot. In some enlargers, the negative stage is left open on three sides for this purpose, but this is liable to weaken the structural rigidity unduly.

Enlarging Easels

Any flat board will serve as an enlarging easel, but its utility is increased if means are provided for holding the bromide paper in position during the exposure, and means of masking the edges to give a white margin are also desirable. There are many ingenious devices, applicable to all types of enlargers, on the market, including tilting easels for horizontal enlargers, which can be loaded in the horizontal position and then swung vertically for exposure; also hinged-frame adjustable masking tables for use on vertical enlargers.

A large printing frame, fitted with a sheet of plate glass, makes an excellent enlarging frame, and may readily be fitted with border masks of any desired shape and size. Its thickness must, of course, be taken into account when focussing, and it is thus advisable to fit it with a piece of plain paper to use as a focussing screen before loading it with bromide paper.

For focussing purposes, a clean white sheet of Bristol board is to be recommended. It should be ruled with centre lines in both planes, and it is also advisable to mark it out to show the sizes of all standard sheets of bromide paper likely to be used, so that the size of image required in any particular case can be instantly seen.

Shutters

An enlarger does not require a shutter as fitted to a camera, but if one happens to be fitted to the lens which is employed, it can sometimes be utilised to advantage in the definite timing of the exposure. It is also possible to control exposure by the electric light switch, and this method is often employed for professional enlargers used for repetition work. One such job, on which the writer was engaged, called for the utmost speed of operation, and to facilitate this, while leaving both hands free, the light was controlled by an ordinary Morse key screwed to the floor and operated by the foot.

For most ordinary work, however, the use of a red filter in front of the lens is preferred, as this allows the image to be seen on the bromide paper prior to exposure. The idea of focussing up on the bromide paper, which some workers seem to entertain, is not a very sound one, as the optical properties of the filter, unless it is a very expensive one, may be dubious, in which case the definition is affected; and the "safety" of the light passed by the filter, unless it is a very deep one, or carefully colour-corrected, is also open to question when it is in use for any substantial length of time. It is generally safe enough, however, for the few seconds necessary to place the paper in position after focussing.

In horizontal enlargers, the filter is usually set in a lens cap which can be slipped over the latter when required; but this is not so satisfactory when applied to a vertical enlarger, and many of these have the filter arranged to swing in front of the lens, in a similar manner to that shown in Fig. 8.

Horizontal *v.* Vertical Enlargers

So far as real essentials are concerned, there is very little to choose between the two types, as both are equally capable of good photographic results; the optical principles are, of course, the same in both. But the majority of amateurs will undoubtedly find the vertical type preferable, on account of its handiness and convenience, and also because it is far better adapted to working in limited space. A miniature enlarger can be set up literally "on the corner of the table," and within the usual limits of head room, will provide sufficient range of magnification for most normal requirements. The flat "easel" is also much more convenient in use than the upright one which is necessary with a horizontal enlarger, and in most cases dispenses with the need for any means of fixing the bromide paper in position for exposure. Another very important advantage of a vertical enlarger is that, as it must be mounted on a fixed column or guide, it will always be quite perpendicular with the baseboard (which is usually a

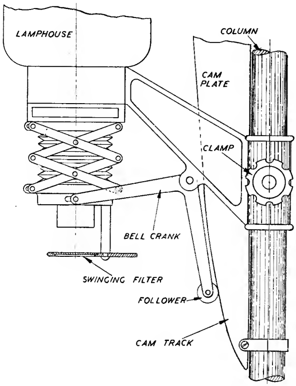


Fig. 8. A simple method of automatically focussing a vertical enlarger. Note that the "lazy-tongs" device is simply a parallel motion for the bellows extension, and does not play any part in the focussing motion, which is effected by a simple bell crank lever.

rigidly attached foundation for the column), and, therefore, cannot produce "rectilinear distortion" or uneven definition through errors of squareness.

It must not, however, be thought that the horizontal enlarger is entirely lacking in special advantages, as there are many duties for which the vertical enlarger is much less convenient, or even entirely unsuited. In cases where abnormal distances between the enlarger and the easel may be required, it is obvious that the horizontal enlarger offers no difficulties in this respect, as it may readily be retracted to any reasonable distance from the easel, and, what is more important, just as easily operated at that distance. Moreover, if mounted on a rigid bench or table, it will be just as steady in this position as when working close up; but this is not the case with the vertical enlarger as usually arranged.

Both horizontal and vertical enlargers are made in all sizes, but, generally speaking, the former are best suited to deal with the larger negatives, which involve the use of long-focus lenses and long distance of projection, while the latter are more suitable for miniature negatives, which allow of considerable magnification at short distance by the use of short-focus lenses.

Incidentally, it may be mentioned that many amateurs who have ideas of building an enlarger with the aid of a cheap second-hand camera, find their greatest difficulty in getting the required magnification at reasonable extension, because the cameras most readily available are all of fairly large size (due to the slump in the popularity of large films and plates) and have proportionately long-focus lenses. Attempts are often made to shorten the focus of the lenses by using supplementary lenses, but it is almost impossible to make any really useful difference without upsetting their correction.

Self-Focussing Enlargers

Many modern vertical enlargers are ingeniously contrived automatically to focus the objective as the body is moved to or from the screen. The mechanism for effecting this is not usually very complex or elaborate in principle, but must be very well made and finely adjusted to be successful in practice. Most of the devices employed are the subject of patents, and it is not, therefore, permissible to incorporate them in a design intended for amateur construction. One of the simplest automatic focussing devices, shown in Fig. 8, consists of a bell crank, pivoted to some part of the enlarger body, one arm being connected to the focussing tube or lens panel, while the extremity of the other arm rests on a cam track attached to the fixed column, on which the enlarger slides. As the enlarger is moved up or down, this arm is displaced horizontally by the

(*Continued on page* 634)

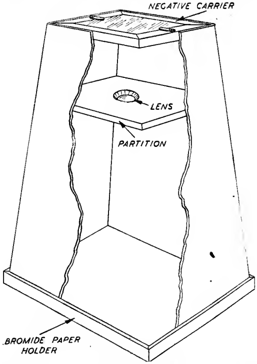


Fig. 9. Fixed-focus daylight enlarger, shown in its simplest form. More elaborate devices, incorporating a lens shutter and a dark slide for the bromide paper, were also employed, and still other daylight enlargers provided means of varying the scale of magnification by bellows extensions or fixed stages.

A Little American Furnace

By James Burton

INTEREST in the type of blast furnace plant extant in the U.S.A. prompted me to adapt my little furnace plant to this type as an experiment. The photographs show the result. No. 1 photo, taken from " charging " side of furnace, shows cast-house, which was added, with slag ladle track emerging from left door just at base of hoist.

This view also gives a good idea of the charging gear layout. Tipping skip will be noticed in the middle of its travel on inclined hoist, which is made in a form of cross-braced girder of mild steel strip. Steel cross struts carry skip track, which is correct " bull head " section model rail, held in spring steel chairs—cushioned by little mahogany blocks, as skip bogey is unsprung.

Just above skip bow may be seen the little chain and eye which connects the main hauling rope to the " shock absorber," made of tough but very resilient rubber. This extremely simple piece of apparatus smooths out the rather abrupt pull the spring-driven hoist motor gives at starting in an excellent manner; in fact, it makes the charging operation as smooth as if the little hoist were fitted with electric motors and push button contactor gear.

At the top of the hoist may be seen guide rails for rear wheels of skip, furnace top platform with stock distributor gear; also discernable are main hauling rope and hook adjuster, with thin rope running down to automatic stopping gear through roof of machinery house. No. 2 photo shows furnace from " casting " or " pig-bed " side. This gives a good view of blast heating apparatus and ancillary gear. Starting from furnace top may be seen the head frame, which holds main hoist rope guide wheel, distributor driving gear, then parallel legs supporting bell-rod guides. Noticeable at edge of top platform are double bell operating levers in fulcrum frame fastened to top of furnace stack, also counter weights to balance large and small charging bells. Passing in between tongs of small bell lever may be clearly seen powerful spiral spring, always in tension, which, with a few links of steel chain, operates

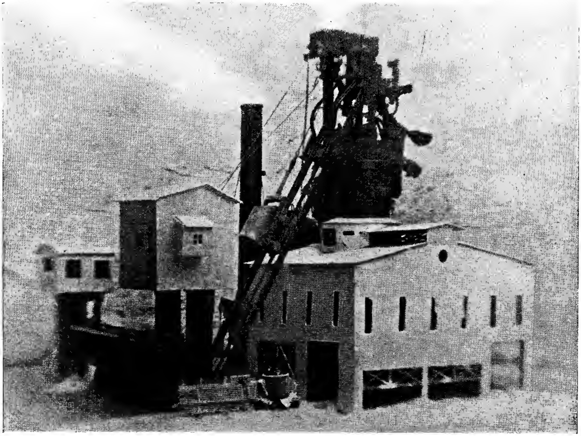


Photo No. 1. Mr. J. Burton's blast-furnace plant.

main bell. At furnace base may be seen emerging from cast-house hot metal ladle track, and casting launder from " tap-hole " in doorway.

The torch and explosion valve, vital accessories to any blast furnace, are shown between stove and top front of cast-house. The double stove chambers with joint in middle are clearly seen.

Some stove operating valves may be seen; gas valve is at left-hand side of front air chamber, connected in centre of stove. Below this chamber is a steel bend-pipe, connected to which is a flexible tube running away to right off the picture to the blowing engines. Then comes the cleaning door, ignition window " tell-tale," tube to cold blast pressure gauge, chimney stack with ejector and valve and operating lever at base, the blast temperature test-valve is noticeable near the truncated base of stack. There are not any hot or cold blast valves necessary with this stove, it being " on gas " and " on blast " simultaneously, and is an experimental one of my own design.

Sintering Experiments

Being one of those mortals who like to get the tools in my hands and experiment " in the metal," so to speak, instead of overmuch drawing-board and formula, I made the sinter plant, shown in No. 3 photo, with a view to overcoming various shortcomings and imperfections they were ex-

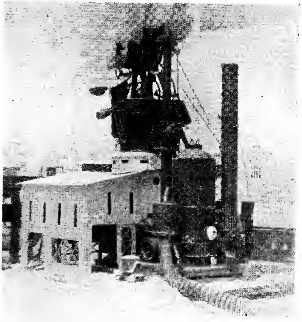


Photo No. 2. A view of the blast-furnace plant from the " casting " side.

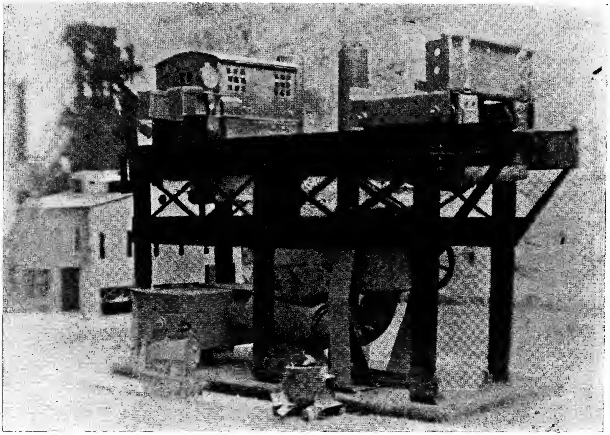


Photo No. 3. The experimental sinter plant.

periencing in full-size sintering practice, as recounted in the various technical journals.

With this little plant, I have learned "very many interesting things" about ore sintering, although it is of only simple construction.

The "firms" assets being practically nil owing to unemployment, ordinary materials had to be used. The base supporting plant is a piece of sheet steel, cut to shape and flanged. On this is mounted the gantry, constructed of steel cut from old bed laths; and gas exhaust system, seen below gantry in picture, is made from light metal tubing and patent food cans. Gearing which operates pan trunnion turning apparatus can be seen in photo, and is made from large clock works. Charging machine and ignition hood travel on top of gantry, and considering the rough materials they are constructed from they operate very well. This charger operates on a system of my own, which, by a combination of various motions as the charge is deposited on the grate bars, gives a very fine "fluffing" action to the descending streams of ore. Ignition hood also operates on my own system, and embodies a special "pre-combustion" chamber which so burns the air and oil that an extremely hot, short smokeless flame is produced, which ignites the sinter mixture on the pan very quickly and evenly. The twin stacks and exhaust system shown provide an excellent "get away" for the products of combustion from the pan, and improve the sintering fan's efficiency.

The results I obtained with this little plant were very encouraging, and the aim of producing a dustless, combustible sinter, not easily broken in transport and with a minimum of "return fines" in the plant system were, as near as makes no matter, realised. I hope to improve on these results when circumstances permit. I have not made my fortune yet, but supposing some chief engineer saw this little plant in the "M.E.," and thought it worth investigating, then you never know what might happen.

When I look back on the time I have spent in experiments with model metallurgical plant, since my school days, and in spite of personal and domestic difficulties, I am amazed at the things I have learned. Also, the value of actual personal experiment, and, last but by no means least, the value of that incomparable journal, the "M.E."

Simple Photographic Enlargers

(*Continued from page* 631)

cam track, and the other arm moves the lens up or down, relatively to the enlarger body.

It is obvious that the exact details of any self-focussing device must be carefully worked out and adjusted to suit a particular length of focus of the objective, as the extension required in relation to distance does not follow a straight-line law. For this reason, it would be difficult to give exact advice on the matter, other than by furnishing formulæ, the application of which might be little easier than working by trial and error. On the whole, the writer does not entirely approve of self-focussing enlargers, except in professional work where the utmost speed is necessary, as they rather detract from the interest to be obtained from operating the enlarger, just as the use of automatic lathes would detract from the interest of model engineering.

Many years ago, fixed focus daylight enlargers enjoyed a fair amount of popularity. These were quite simple devices, consisting, in most cases, of a long rectangular box, as shown in Fig. 9, having a negative holder at one end and a dark slide or holder for the bromide paper at the other. The lens was fitted in an internal partition, located so as to be exactly in focus for the magnification employed, which was usually to a definite scale of the original.

Such enlargers were usually loaded up in the dark room, then brought out, and the negative end exposed to diffused daylight for the required length of time to print out the image on the bromide paper. They gave quite good results when properly used, but it was often a disadvantage to be restricted to a fixed magnification, and, in addition, the matter of exposure was little more than guesswork, owing to the variability of daylight conditions.

These enlargers have become practically extinct nowadays, and it is doubtful whether any are made commercially, but of recent years a similar idea, with certain refinements, has been applied to artificial light enlargers. The most important application of this principle is in commercial "D. & P." work, where large numbers of fixed-scale enlargements are required from miniature negatives. It is usual to arrange the enlarger with the negative end downwards, the illuminator (which may be of the condenser or diffused-light type) being attached underneath, and the stage for the bromide paper being exactly similar to that of the ordinary contact printing machine. The operation of the device is also identical, even, in some cases, down to the automatic switch for controlling exposure. This is a great advantage for the purpose in question, because no specialised skill is necessary in handling the enlargers, and operators who have been used to contact printers can be transferred to them without special training or instruction.

Fixed-focus enlargers of any type, however, are by no means so attractive to the amateur worker as, quite apart from their lack of flexibility and the impossibility of "control" in composition and exposure, the fact that they are operated in the same way as contact printers destroys much of the fascination of one of the most interesting processes in photography.

The Lady in the "Back Shop"

By "L.B.S.C."

SEVERAL times we have had pictures in these notes showing feminine engine-drivers on the job, but up to the present the loco. "fitterette" has been conspicuous by her absence. Well, here she is at last, in the person of Mrs. Rose, wife of Mr. J. Rose, a South London reader, who is an ardent Brighton "fan" and has built several *real* "0" gauge "Live Steamers" of L.B. & S.C.R. type; one of them, a "B4X," is shown in the other picture. Mrs. Rose, with the true feminine touch, has chosen the smallest and prettiest type of locomotive ever seen in regular passenger service on the standard gauge, viz., a Brighton "A" class "Terrier" tank ("hear-hear" and loud cheers from Mr. J. N Maskelyne!) for her effort, a real "watchmaking" job at that; but from my own personal knowledge of the skill and dexterity that "the girls" can show when they really get down to it, I have not the slightest doubt that the little engine, when completed, will be a fine piece of work.

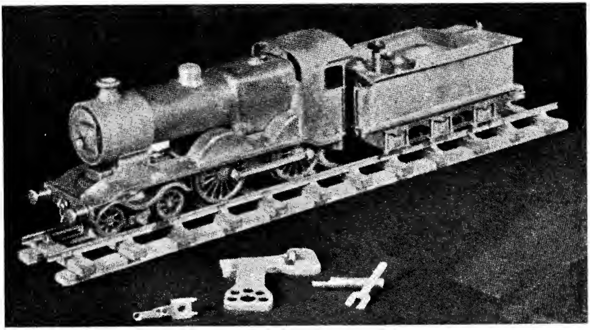
"Information Bureau"

A few days ago, time of writing, a follower of these notes sent a simple query which is, in a sense, rather extraordinary, so I think a few words on the subject would not come amiss. He wanted to know if he should fit a displacement lubricator to his engine instead of a mechanical lubricator as specified, saying he had heard that the latter gadget not only took a considerable amount of power to drive it, but was unreliable. The querist is a "first-timer" and was perfectly serious, otherwise I might have suspected a little subtle leg-pulling! However, in case any other "brother novices" get hold of the same idea, it would be just as well to dispel any doubts and fears by a little simple analysis.

First of all, as to power required. Take the average type of mechanical lubricator specified in these notes for $2\frac{1}{2}''$ and $3\frac{1}{2}''$ gauge engines. It is driven by a ratchet-gear and has a bore of $\frac{1}{8}''$, varying between $5/32''$ and $\frac{1}{4}''$ stroke according to size of engine. First, on the ratchet lever, we have an initial leverage of approximately 4 to 1, between the point of application of power and the point where the power is delivered. Then we have the ratchet-wheel itself. I usually specify 35 teeth, which means that the driving wheels have to make 35 revolutions to one stroke of the pump, which is driven through the leverage already mentioned. Then consider the small amount of back thrust upon a $\frac{1}{8}''$ piston, which only pumps against anything like full boiler pressure when the engine is starting against heavy load; and you will realise at once that the increase of power required of the locomotive cylinders to drive the lubricator is so small as to be practically non-existent. In point of actual fact, locomotives which I have converted from displacement to mechanical lubrication—old "Ayesha," for example—have not shown the slightest decrease in tractive effort after the mechanical lubricator was fitted. On the contrary, there is a distinct improvement, consequent upon the regular supply of a definite quantity of oil being delivered in accordance with the number of strokes made by the pistons.

Mrs. Rose at work on her L.B. & S.C.R. "Terrier."

Compare the above with the power required to drive the ordinary eccentric-driven boiler feed pump. First, the eccentric drives the ram direct, with no intermediate lever to give an increase of power; secondly, the pump makes one complete stroke per revolution of the driving wheels, instead of one to thirty-five; thirdly, the diameter of the ram is $5/16''$ or larger, and pumps against the full boiler pressure all the time the pump is feeding.



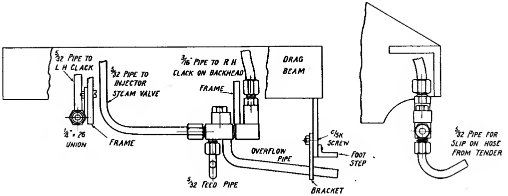
Mr. J. Rose's "O" gauge Brighton "B4X."

A boiler feed pump *does* require a certain amount of power to operate it, yet I do not recall anybody wishing to dispense with it and use a hand pump on that ground alone. An old friend certainly raised objection to fitting an eccentric-driven pump to a ball-bearing locomotive, on the ground that it would interfere with free coasting; but even that proved fallacious, for I eventually fitted one to the engine, and it made no appreciable difference at all.

Some years ago, before I had my present line, an engine was brought for a test run on my old road. It was fitted with a small tank in the cab, containing a pump operated by hand; and this was used for cylinder lubrication whilst running. Every now and then, the owner of the engine would give the handle of the pump a push, upon which some drops of oil would fly out of the chimney. I asked him why he did not let the engine itself drive the pump, and feed in the oil on the correct "little and often" system, which was far more beneficial to the valves and pistons. His reply was, "Oh well, if you shove it in by hand you know she gets it!" I thought this a very poor argument indeed, but held my peace; everybody to their own liking! His engine had an eccentric-driven boiler feed pump, so I might have retorted, "Why, then, don't you use your tender hand pump all the time, instead of letting the engine pump its own water? You would know then that she gets it." This would have been just as logical! If a pump does its duty, then the means by which it is operated can have no effect on the delivery; and with the ram mechanically operated, you not only "know she gets it," but what is more important, you know she gets the *correct amount at the proper intervals*. Hand operation cannot be anything but irregular, both in time and quantity supplied.

There is, however, one point which needs careful watching in any mechanical lubricator, but which is not so important in a hand-operated pump, and that is the ram must be an absolutely oil-tight fit in the barrel. This may be obtained either by a perfectly round ram fitting in a perfectly round hole, or else by the provision of a gland. In the earlier lubricators described in the "Live Steam" notes, I specified a reamed bore, with a ram made of ground steel fitting in it, no gland being provided. Now in the lubricators of my own make, I did not rely on commercially-ground stock, but made my own; hence the rams *actually did* fit the bores, and worked perfectly oil-tight. However, some good folk who made them used an ordinary reamer, and fitted rams made from "ground rustless." The lubricators either failed to deliver the goods or else became full of water. I examined several samples sent for inspection, and in every case the "ground rustless" rams were anything but round. If held between finger and thumb, and turned around, the irregularities could easily be felt. As a test, I filled each cylinder barrel with oil, held my thumb tightly over the port, and pressed in the ram. The oil escaped between ram and cylinder bore.

What happened in service was this. With a ratchet drive, the movement of the ram is very slow, which is, of course, correct practice, as the charge of oil is slowly forced in during 12 to 15 revolutions of the wheels, not shot in all at once and immediately blown out of the chimney. If the delivery clack is leaky—and it is absolutely astounding to find what a number of locomotive builders there are who cannot make a steam-and-



How to fit the injector.

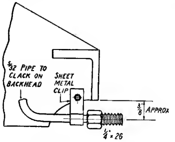
water-tight clack!—as soon as ever the ram starts on its delivery stroke, and opens the oil port, steam blows past the leaky clack, down the delivery pipe, into the pump cylinder, and forces out the oil between the badly fitting ram and the cylinder bore. The slow motion allows the pump cylinder to be completely emptied by the time the ram reaches the bottom of the stroke, and so the engine cylinders get no oil. If such a wretchedly fitted pump were hand-operated, the quick movement of the lever would not give the steam time to blow all the oil back, and some would enter the delivery-pipe and reach the engine cylinders. The maker of the pump, not knowing nor troubling to find out the truth of the matter, immediately condemns the mechanical lubricator, and uses a "flood-and-starve" hand-operated gadget, explaining to all and sundry that "mechanical lubricators are no good."

Every failure I have seen has been made to work perfectly, simply by counterboring the end of the pump cylinder, tapping it, and fitting a little gland packed with graphited yarn. It does not then matter if the ram is polysided; so long as no oil can escape from the cylinder by getting past the ram, the pump, if of the oscillating cylinder type, would function without any clack at all. Another good wheeze is to put a loop in the delivery pipe connecting the lubricator with the steam-pipe or steam-chests. The lengthened pipe prevents heat being transmitted to the lubricator, and making the oil in it "go thin." Before leaving the subject, I might mention that I have tried lubricators with smaller rams, 3/32" and 1/16" diameter, and made one of the latter size which will deliver one drop of oil for every 40 strokes of the engine cylinders. This will provide the cylinders of a $2\frac{1}{2}$" gauge locomotive with sufficient oil for lubricating purposes, whilst preventing waste blowing out of the chimney, and allows a run of over three miles at one filling of a normal-sized oil container. These lubricators differ in several respects from those already described, and if all goes well I hope to give a sketch and a few details in due course.

Miss Ten-to-Eight

How to Fit the Injector

Eh—used up all the "72" drills! Well, that is just too bad! Never mind, you have probably made the little squirting apparatus, and are waiting to know where to put it. The sketch shows where I fitted Maisie's, and it was out of the way and worked well in that location, so I do not think we can better it. First hold the injector in place, and make a template with a bit of soft copper wire for the pipe connecting the union under the steam-valve on the boiler backhead to the steam union on the injector, giving it an easy bend, as shown. Straighten out the wire, and cut a piece of 5/32" by 24 gauge copper tube to the same length. Put on a couple of $\frac{1}{4}$" by 40 union nuts, and silver-solder a little union cone on each end. By the way, readers who have small lathes



Connection for tender pump

with a single slide-rest which will not set over to turn tapers, can easily make these cones by using a tool ground off diagonally at the end. You can get the correct angle by putting a Slocomb or other centre drill in the chuck, and grinding the tool until it touches all along the tapered part. Drill the nipples No. 40 and counterbore the backs with a No. 22 drill, so that they are a tight fit on the pipe. When silver-soldering, be extremely careful not to get any silver-solder on the cone part, or the unions will not be steam-tight. Also heat the whole length of the pipe, and quench out in pickle, then wash in running water, letting it

swill through the pipe, so that no bits of scale are left in, to choke the little jigger nozzles. Clean up the pipe with a bit of steel wool—bright copper pipes look pretty on the footplate—bend to shape and couple up, adjusting position of injector. This pipe will hold it in position whilst the next one is fitted.

Measure again with the copper wire, from the top union of the clack on the injector, to the union on the right-hand delivery clack; then cut a piece of 3/16" by 24 gauge copper pipe, fit with union nuts and nipples as above, and couple up.

Keep in Sight

As this injector will be used whilst running, you will want to see the end of the overflow pipe, same as on a big engine, to ascertain that the water is going into the boiler, and not on the permanent way. To this end, it should be bent almost to a right-angle, and led to a position underneath the right-hand step. Soften and clean the pipe, put a few threads on the end, holding the pipe in the three-jaw and screwing it with a die in the tailstock holder; then screw home, and bend afterwards. Finger pressure only will do the trick, without kinking. A little bracket, of 16 gauge brass, is then made, and a hole drilled in it for the pipe to pass through, see sketch. The bracket is attached to the back of the step by a small screw and nut.

The three pipes support the injector with ease, as it only weighs just over an ounce, complete with clack, and no further fixing will be needed. Connection to the tender tank is made by a little swan-neck of 5/32" pipe attached to the water union on the injector, by the usual nut and nipple, see sketch. The water regulating-valve will be fitted on the tender, and the feed-pipe coupled to the injector by a slip-on rubber hose, known to enginemen as a feed-bag.

Hand Pump Connection

Measure once more with the copper wire, from the left-hand clack union on the backhead, to a point under the drag-beam, as shown in sketch. Cut a piece of 5/32" copper tube to length indicated, and on one end of it silver-solder a nipple with a nut for connection to the clack. On the other end, fit a union screw turned up from a $\frac{3}{4}$" length of $\frac{3}{8}$" hexagon brass rod, and screwed $\frac{1}{4}$" by 26, the coarser thread being easily engaged and quickly coupled. Countersink the screwed end deeply, drill right through No. 40, and counterbore the hexagon end No. 22, silver-soldering the pipe in place. Pickle, wash, clean up and bend to shape; couple up the union at the clack end, and attach the other end to the frame by a little clip, as sketch, made from 16 gauge sheet brass, and secured by a screw and nut. The pipe may, if desired, be soldered into the clip to prevent it from becoming twisted or otherwise damaged when coupling or uncoupling in a hurry.

For the Bookshelf

Diaries for 1940.

We have received copies of pocket diaries published by our contemporaries, *The Amateur Photographer, The Wireless World, The Motor Cycle* and *The Autocar*. Each is nicely bound in leatherette, and, in addition to the usual pages for personal memoranda, contains a considerable amount of useful information appropriate to its particular subject, illustrated where necessary with clearly reproduced drawings and diagrams. The price is 1s. 6d. each, net, and copies may be obtained from either of the above-mentioned journals at Dorset House, Stamford Street, London, S.E.1.

Science for Handicraft Students. By H. Morton, B.Sc., A.Inst.P. (London: E. & F. N. Spon, Ltd.) Price 7s. 6d. net.

This book should be useful to students and craftsmen alike; the former will find it an excellent textbook of elementary science, while the latter should be able to acquire some knowledge of the scientific principles underlying the processes employed in the workshop, more particularly as regards the application of those principles to wood and metal work. There are sixteen chapters, each with a selection of exercises at the end.

The New "Coronation" Brochure

The smart threepenny catalogue of gauge "0" railways produced by Bassett-Lowke, Ltd., last Christmas season proved so overwhelmingly popular that they have again published this list, and the new issue came out on December 4th. In place of the blue and silver cover, it is now maroon and gold—the "Coronation" in her new colours —and inside are given the latest developments in models and also revised prices. Some prices, readers will be pleased to learn, can now be maintained at their old pre-war level. This book is called "Bassett-Lowke Gauge '0' Scale Model Railways" (section GR), and costs 3d. post free. Other new catalogues include the November, 1939, issue of the "Twin Train Gauge '00' Railway," price 2d. post free; and a newly prepared "Ship Catalogue," price 6d., for 1940 will be out during December.

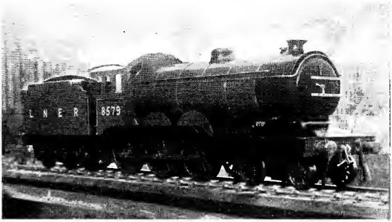
Bassett-Lowke's model maker's handbook, "Steam Locomotives, Stationary Engines and Everything for the Model Constructor," 8d. post free, published in September, is proving very popular among model engineering enthusiasts.

All these lists can be obtained over the counter at their London or Manchester branches, or by return of post from Northampton.

"B.12"

A ½" scale L.N.E.R. locomotive

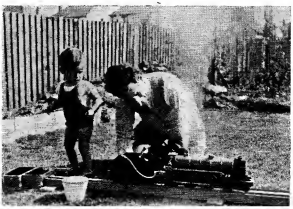
By W. H. Robertson



The ½ in. scale "B.12." The snifter behind the chimney is a working model.

THIS model is a true ½" scale (not 17/32") model of a Great Eastern Section re-built "1500" class locomotive. It is a coal-fired water tube boilered job, and is, as far as I know, the third of this type to prove that such boilers can be coal-fired successfully. Readers will probably remember an article on this subject in the "M.E." by Mr. N. Dewhirst. He described a 4-6-0 and an 0-6-2 tank. These are the "other two" referred to above. In passing, I might mention that Mr. Dewhirst is a friend of mine, and a very modest gentleman indeed. His claim that both his engines are "successful passenger-haulers" merely states the bare fact; he omits to add that they are always driven as such, and that each of them (the 0-6-2 tank has 17/32" × 1" cylinders) have hauled two adult passengers, and would quite possibly manage three if there were room for more feet on the trolley! I can vouch, especially, for the 0-6-2 tank, as I have driven her myself. She is easy to handle, easy on fuel and does not suffer from wheelspin.

Well, it was Mr. Dewhirst and his engines which, after many years of doubt and indecision, at last got me going—it was the boilers which did it, for I had previously been led to believe that such an arrangement would not pan out well in practice. When I saw two of them doing their stuff, the biggest stumbling block was removed, and I had to agree that the simple Smithies, with a spot of best quality anthracite in a *properly arranged* grate was capable of producing a surprising amount of steam. This "grate" business is most important, but more about that anon!



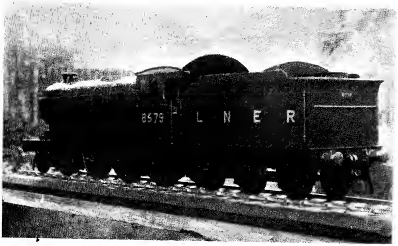
The first track test, with a borrowed tender. The fireman looks a bit worried!

Anyway, Mr. Dewhirst and myself put our heads together and did some careful scheming, the result of which was a 2" dia. boiler barrel with four 3/16" bore water tubes arranged in pairs, one pair each side of the fire, thus leaving the portion of barrel immediately above the fire free of tubes altogether. This made for easy firing. At the front end of the barrel the four tubes are side by side, but as we move aft the centre two splay out and sit one above each of the outer ones. This sounds a little involved, but is really quite simple. The result gave me, in effect, actual water space each side of the fire, which could be piled up between the pairs of tubes and in contact with them. So far so good! The actual firebox was bent up from a strip of 1/16" thick brass; it was 4" long and 1 1/16" wide and was lined with 20 gauge soft iron. This latter was made easily replaceable, as it was sure to burn out after a time. The outer casing is 3" dia., and is also lined with 20 gauge iron spaced in 1/16". It was hoped that this would prevent the paint from burning—it did, the paint is as good as new after about 20 hours' steaming, except where hot oil has blistered it off.

Perhaps I should now, after so thoroughly putting the cart before the horse, say a few words about the chassis! This follows standard practice, 3/32" steel frames, pressed horn-blocks, etc., and Bassett-Lowke's wheel castings finished in my 3" lathe. These latter are almost the only castings on the job, everything being built up or machined from the solid. The cylinders, 11/16" bore × 1" stroke, were

chewed out of a block of hard drawn brass. Ports are 5/16" long × 3/32" steam, 3/32" bar, and 3/16" exhaust. Valves were made 11/16" long, and eased down when tuning up until the very necessary "black line" showed each end when the wheels were revolved in mid-gear. The gear is Walschaerts, not because the prototype has it—it has not—but because I think I understand it, and because I like to see the expansion-links "waggle" backwards and forwards in an inside cylinder job.

The crankshaft was built up and silver-soldered—or, rather, it was to have been silver-soldered but an over-zealous friend at the business end of a 3-pint blowlamp melted the brass eccentrics, which had been threaded on during the building up process, and effectively brazed up the whole issue! The remaining blobs of brass were laboriously cleaned off, and the shaft very carefully centred. Fortunately, the bright round rod used was about 5 thous. over size, and I was able to finish it by turning them off in the lathe. New eccentrics were fitted by simply making them complete with bore and then cutting out to the nearest point in the periphery with a saw! It was then possible to force them into position between the crank-webs. They were then pegged to each other and to one web with steel pegs and sweated up with soft-solder. They have never moved, and I guess they never will!



Note the clean lines, with no "out of scale" details.

There is a crosshead pump, 3/16" bore × 1" stroke, and many anxious days and nights were spent in scheming before I finally got it in. There was not any room for it! The valve-gear filled all the available space, and it could not go under the cylinders because of the bogie. Eventually it was stowed away under the crankshaft and partly behind it. A long, awfully bent rod connects it to one crosshead, and it is fascinating to watch the pump ram get out of the way just in time to miss the crank-web as it comes round—it has not hit it yet! It is a very "un-engineering and truly 'orrible" arrangement, but it works and as yet shows no signs of wear.

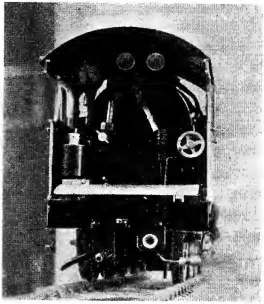
Eventually the great day came, and a cycle pump was connected by means of a rubber tube to the cylinders. The first shove blew the tube off, so I put it on properly and had another go. This time she moved, and I went to bed that night feeling as though both my arms were going to fall off at any minute. Next day I borrowed a motor tyre pump! The beat was even and snappy in both directions, and the engine would almost, but not quite, move in mid-gear, in whichever direction I started it. I was quite surprised, knowing my own workmanship, and, of course, delighted.

Well, that was that, so we got on with the boiler. Being a "cack-handed" sort of individual, I told you about that first, so we only need mention the trimmings. There is a blower, and the jet is so small that only the first ⅛" of the wife's smallest sewing needle will enter it. This hole is more than sufficient and usually the blower-valve is almost shut, both standing and running. There are two safety-valves, set to 75 lb., and although they were not designed to pop they do pop! Other fittings comprise pressure gauge, water gauge, check-valve, bypass cock and screw reverse. There is also a spare screw-down valve. In the cab also, is situated the cylinder lubricator, and thereby hangs a tale. The matter of cylinder lubrication was considered vital and so, in the first place, an ordinary screw-down plug affair was fitted, which squeezed oil along a pipe into the cylinders. A plug cock was fitted in the pipe to prevent blow-back. With this arrangement, I knew jolly well that the oil was going where I wanted it. But it had a snag—I kept forgetting it altogether, and when I did remember it I frequently burnt my fingers trying to wangle the cock on and off, the cock being well down in the front left-hand corner of the cab. So I got busy on scraps of paper and designed, roughly, a couple of thousand different types of lubricators. Mr. Dewhirst came into the fray and designed a couple of thousand more! The result to date is that the old reliable screw-down is still on! All the posh affairs we produced, some of them quite new, and, although I say it myself, quite ingenious, have some snag or other—they were too large, or too small, or you could not tell whether the oil was really going in or not, or my abilities as a fitter and turner would not stand the strain of making them. I did, at one time, rashly promise myself that I would make an "L.B.S.C." oscillator, but made size an excuse not to tackle it, "It would look too big on the footplate," and I had nowhere else to put it. So I continue to forget, and burn my fingers!

Well, if you have had patience enough to read as far as this, I expect you are anxious to learn whether the engine is a success, or works at all, so here are some notes on tests. In the first place, and in order to run her in a bit, we bench-tested her, and the highlight of that test was the following. The gauge showed 25 lb., the blower was just on, the fire just breaking through, and the engine in full-gear. We had no mechanical pump on at the time, and the level was up to the top nut. A piece of rag was pressed against the leading wheels and the regulator opened fully (the cylinders had been previously warmed up, of course). She began to turn and pressure on the rag was such that her speed was restricted to about 100 r.p.m. After 30 seconds or so, pressure was up to 40 lb., and I had to push pretty hard on my piece of rag. At the end of two minutes I could not hold the wheels at all, and she was blowing off at 75 lb.! This seemed good enough for me! The fire was then going very nicely and ready for a spot more fuel, and that two minutes had half-emptied the boiler!

After that I borrowed Mr. Dewhirst's trolley and tried some passenger work. In this direction I was not so lucky. I could not see the fire so well when the engine was down on the floor, and consequently I made lots of mistakes before I got going properly. She would pull me, but was a shy starter and I could not keep steam. Also, she developed a bind which took me a long time to find, and she used to run jerkily. Eventually I discovered that the coupling-rods were the culprits. Easing the bushes in same cured the bind. The best run obtained during this time was on 20′ of track on the lawn. I had no spirit level, and so I guessed it and hoped for the best (I was in a hurry, anyway—always am for that matter!). Well, we warmed up and sat on the trolley. Full-gear and half regulator with the safety-valves, or one of them, just lifting. She just sat and made blowy noises at me, so I shoved off. Away we went, with loud and beefy beat, not accelerating much but making a lovely noise. In due time, about 5′ from the end, I shut off. We stopped in a surprisingly short time and immediately began to run backwards, engine, tender, trolley and me, and had I not put my feet down as soon as I got over the shock I reckon I should have gone clean through the fence! Goodness knows what the incline was. I could not alter it then, however, so carried on, and twice during the test she started me unaided—slowly but surely mounting the gradient to the top. I had no slipping troubles, probably because both wheels and track were new, and not rolled out to that annoying smoothness which causes model loco. men to tear their hair and call for the sand!

Subsequent tests have shown steady improvement, probably because I am getting used to her. There is no difficulty in maintaining steam, and a whiff of the blower keeps the valves just on the lift when standing. When running, I find that, properly handled, she will blow off as soon as I shut the regulator. The original long firebox had a fault, however. I discovered that although the fire burnt all right, it was better at the front end than at the back. Also, the axle which passed through the ashpan got unduly hot and dried the oil out of the boxes. I killed two birds with one stone, and also obtained an all-round improvement by taking this box out and fitting a new one, only $2\frac{3}{4}''$ × $1\frac{3}{8}''$ overall, with semi-circular ends. With this I got a hotter fire, due to smaller area, *with greater width*. In more nearly approaching a square in shape, I minimised the heat dissipation and got more where I wanted it. The axles and boxes now remain oily under all conditions. Firing is easy. We light up on charcoal, from a Meta fuel tablet in the ashpan, maintaining draught with a cycle pump connected to the feed line, and when alight anthracite is added. Once



The controls. The screwdown cylinder lubricator is on the left. Cycle valve cap below footplate on right is for pumping air into feed line when raising steam.

on the go, we fire on anthracite alone; roughly one shovelful every five minutes. The fresh fuel is always put at the back of the box, the previous shovelful being pushed forward at the same time. Thus, some portion of the fire is always bright, and this seems to be the secret of success with this type of boiler. When packing up, and adding no more fuel, the fire will maintain full pressure under working conditions for about 15 minutes. Steam raising takes about seven minutes from lighting up to blowing off. Mr. Dewhirst's engines are quicker on the uptake than this, but, somehow, I have been unable to better my seven minutes.

However, I am very pleased indeed with my "B.12," and to those who are afraid to tackle a loco. because of the difficulties of making the boiler I would say, as Mr. Dewhirst also said in his article, "The simple type of engine can be perfectly satisfying—try the simple type of loco."

*Model Aeronautics

A series of articles dealing with the theory and practice of model aeroplane building

By Lawrence H. Sparey

THE situation of the engine at the nose of tractor model aeroplanes renders it particularly liable to mishap. As model I.C. engines are valuable property—expensive in money if purchased, and expensive in time and skill if home-made—it behoves us to safeguard them in the best possible manner. Apart from such devices as the flexible engine mounts, recently described in these articles, the only practical way to protect the power unit from contact with "undesirable" obstacles is by means of the undercarriage. The placing of this well forward (as shown in Fig. 80) so that the wheels are just in front of the propeller blades will have the desired effect, and I have flown models for many years with safety, using this device alone.

Springing the Undercarriage

This consideration has an effect upon the design and type of the undercarriage, particularly in the matter of the direction in which the undercarriage legs are allowed to spring. Many undercarriages with a spring action, designed to damp out landing and other shocks, move in a backward direction, thus allowing the balloon wheels to be displaced from the position of most usefulness. This applies particularly to those types with an excessive amount of backward springing. In any case, very little springing movement should be required, as balloon wheels—such as those described in our last article—may be a sufficient shock-absorbing device in themselves.

Undercarriages with legs which move in an outward or sideways direction (in opposition to those which move in a forward or backward direction) are to be preferred for several reasons. One of these is that, with moderate springing, they allow the wheels to retain their desirable forward position. The most important consideration, however, is that, with legs moving in an outward direction, the wheels are always in the same relative *longitudinal* position with regard to the centre of gravity of the aeroplane. The matter will be made clear by a reference to Fig. 81. The undercarriage leg shown in full line indicates the usual situation of a leg with a backward movement in relationship to the C.G., while the dotted line illustrates how the C.G. is thrown forward in relationship to the wheels, when they are sprung back on contact with the ground. This virtually makes the *ground* stability of the aeroplane nose heavy; thus engendering a tendency for the engine and propeller to topple forward—especially if the undercarriage wheels become entangled in grass or other impediments. Obviously, if the undercarriage legs are movable only in a sideways direction this cannot happen, and the ground stability always remains constant. Furthermore, the same principles apply when the machine is taking-off from uneven ground.

Skidding

A sideways movement is often embodied in the undercarriages of full-sized aeroplanes, and the wheels may plainly be seen to skid in an outward direction as the machine touches earth. This skidding of the wheels acts as an additional brake upon landing shocks—the check being the friction between the tyres and the ground. The action may be more readily understood if one considers the damping effect of such a friction as applied to a spreading undercarriage of the "scissors" type, such as illustrated in Fig. 82. It will be evident from this drawing that a considerable check upon the landing shock would be supplied by any

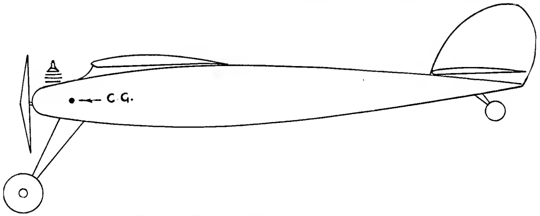


Fig. 80. The undercarriage placed well forward.

* *Continued from page 566, "M.E.," November 16, 1939.*

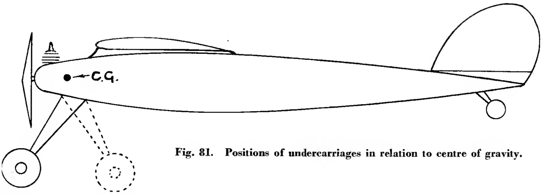


Fig. 81. Positions of undercarriages in relation to centre of gravity.

friction device applied to the top of the "scissors." Such an action is just as effective if the friction be that between wheels and the ground.

Although Fig. 82 is a representation of a theoretical undercarriage, such an action has been used in practice, and is quite efficient. The two photographs (Figs. 83 and 84) are of an undercarriage of this type, which was fitted to an aeroplane of $4\frac{1}{2}$ lb. in weight. It will be noted that the springing is effected by means of two short tension springs, operating at the tops of the legs. As each leg is separately pivoted at the bottom longerons, this is not, strictly speaking, a "scissors" action, but the principle is so closely allied that a distinction becomes a mere quibble. An aluminium rod, which is secured between two strong bulkheads, acts as a stop for the legs when at rest under the pull of the springs. Readers who may design upon this principle are warned that the legs act under considerable strain and they should be made of very strong material. In the case illustrated, legs of whitewood, mahogany and oak were abandoned for even stronger ones of English ash.

A method which lightens the strains imposed on the legs is shown in Fig. 85. In this, the legs are strongly hinged to the lower longerons of the fuselage, and springing is provided by rubber bands concealed in tubes. These tubes may be constructed from many layers of gummed paper parcel-tape wrapped around a dowel, or of 1 mm. three-ply wood, steamed and bent into a tubular form. They are then bound with silk and doped. In the illustration, the ends of one of the tubes is shown as if cut away, to reveal the rubber bands and fixing hooks.

Correct Springing

Should this system be used, care and experiment is required to obtain just the right amount of springing; either by altering the number of

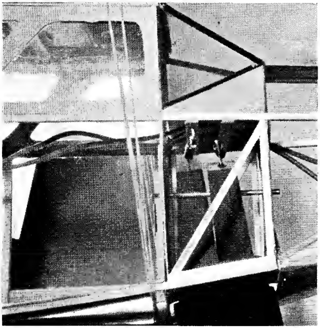


Fig. 83. A scissors-type undercarriage, showing the springing and the check bar.

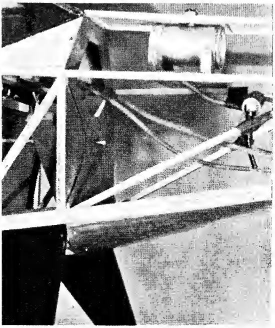


Fig. 84. Another view of the same undercarriage, showing the stout forward bulkhead.

rubber bands, or by locating the tubes higher or lower down upon the undercarriage legs. The nearer these are to the wheels the greater the leverage with which the rubber bands operate. If,

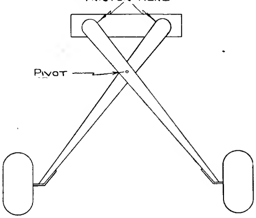


Fig. 82.

on the other hand, the rubber bands are insufficient, or are situated too near the hinge of the legs, the undercarriage will open out flat during a heavy landing, and the propeller and engine may be damaged.

The ideal system is, undoubtedly, that provided by compressed air, and it is quite possible to construct undercarriages using this means from simple and easily obtainable parts. An ordinary, celluloid, cycle-tyre inflater forms a good basis upon which to build, as this is a very good compressor of the " barrel and plunger " type.

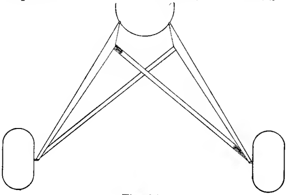


Fig. 85.

The pump barrel and plunger rod may be cut to any desired length, and the closed end of the barrel is easily secured to the fuselage by fitting a screw into the threaded hole provided for the usual pump connector. A suggested lay-out is provided in Fig. 86.

In this design, the wheels are secured to a spindle at the apex of an inverted " V " of stiff, steel wire (usually about $\frac{1}{8}''$ in diameter). The apex of the " V " may be linked together, or may be formed from a single length of wire, the spring of which will allow for any upward movement of the wheels. The top ends of the wire legs are bent inwards to locate in runners of sheet aluminium, which are secured to the fuselage sides. It is apparent that we have now constructed an arrangement which allows a free movement of the wheels in an upward direction. By placing the pump action in the position shown, any undue movement of the wheels will be checked by the compression of the air within the pump barrel. A light tension spring should be embodied in the design to pull the legs to their original situation

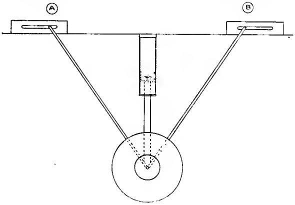


Fig. 86.

after they have been depressed, and the runners will probably have to be longer than those shown in the drawing, so that the side wires do not " bottom " under heavy load.

An alternative suggestion is to pivot the front leg at the point *A* in the drawing, and to mount the compression cylinder horizontally, at the point *B*; so that the movement of the rear leg actuates the plunger. The principle will lend itself to endless variations.

It is always my aim to indicate principles rather than completely detailed and finished designs, except, as with balloon wheels, for instance, when the efficient functioning of the design depends upon details. To my mind, half the pleasure of our hobby lies in the working out of the small problems connected with it, and the builder will be a better engineer for the experience. I shall be accused of uttering a trite remark when I say that we learn more from our own mistakes

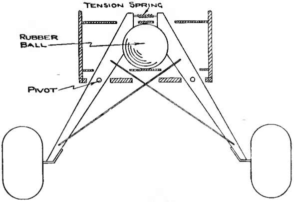


Fig. 88.

Fig. 87. A fine example of a neat undercarriage. In fact, this " Rearwin Speedster," built by Mr. Rushen, and powered with a " Gwin " engine, is an excellent presentation of the modellers' art.

than from the successes of others, but I will let it stand, as it is only its essential truth which makes it a platitude.

In the undercarriage just described, the wheels have only an upward movement, but the system may be applied to those in which the legs have an outward motion. In this case, the compressed air cylinder and plunger will be arranged to replace the rubber bands used in Fig. 85, or may be situated between the tops of " scissors " legs. An ingenious extension of this idea is shown in Fig. 88. In this, the legs are pivoted, near the top ends, to the fuselage, and a rubber play-ball (not of the solid type) is held between the upper extremities, in a plywood box, within the fuselage.

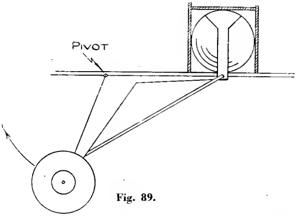


Fig. 89.

The bottom of the box is suitably slotted to allow free movement to the undercarriage legs. From the lower end of each of these, a bracing wire is crossed to attach to the top of the opposite leg. These wires serve to hold the legs in position, and to prevent any excessive amount of movement. If the working of the undercarriage is traced through on the drawing, it will be seen that the spreading of the legs under the weight of the machine is controlled entirely by the compression of the air within the rubber ball. A small tension spring, hooked between the tops of the legs, serves to return them to their correct position if they are inadvertently pressed inwards.

Although a spreading or upward movement of the legs is to be desired, there are many undercarriages constructed in which the legs spring in a backward direction. If the movement is not too great, some very satisfactory types may be designed. One of the great drawbacks with mechanical springing of the compression type, is that of the springs " bottoming " on maximum impact. All those systems which rely on compression springs within telescopic legs suffer from this disadvantage, although this type is extensively used—presumably because of the " obvious " nature of the design. Nevertheless, there are several alternative methods which are better, such as that depicted in Fig. 89. I have purposely selected this undercarriage for description as it again employs a rubber ball as a shock absorbing device; thus illustrating a fresh application of an already mentioned method. My object is to encourage readers to expand or modify the ideas shown.

A Shock-Absorbing System

Fig. 89 shows an " undercart " working upon the " bell-crank " principle. The wheels are well in front of the power unit, and, on striking the ground, they become even more so. This tends to make the aeroplane *tail heavy* upon landing, and a machine so fitted will never topple upon its nose. It will be seen that the undercarriage is pivoted to the fuselage, from which point a lever-arm projects backwards. From the extremity of this lever-arm a stirrup encircles the rubber ball, which is suitably retained in a box structure. The weight of the machine in landing depresses the undercarriage legs, thus pulling the stirrup down upon the rubber ball. Such a shock-absorbing system will never " bottom."

(To be continued)